The Mars Astrobiology Probe: A proposed instrument suite for the 2009 Mars Science Laboratory (MSL)

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We have proposed for the MSL Investigation to carry out a series of experiments using a groundbreaking new instrument concept, the Mars Astrobiology Probe (MAP). The MAP experiments are designed to address in a robust and comprehensive manner one of the primary goals of the MSL investigation, which is "to assess the biological potential of a least one target environment identified prior to MSL or discovered by MSL". MAP consists of four separate major components: a subcritical water extractor (SCWE); the Mars Organic Detector (MOD): a novel lab-on-a-chip micro-capillary electrophoresis (CE) system; and the Mars Organic Reactor Suite (MORS). SCWE is used to extract the target compounds from samples provided by the MSL sample distribution system. MOD next uses sublimation at Mars ambient pressure to extract, purify and concentrate organic compounds from the SCWE extract. MOD then assesses presence of two target classes of compounds, amines/amino acids and polycyclic aromatic hydrocarbons (PAHs), by measuring the fluorescent response on a MOD capture cold finger. In the case of amino acids, fluorescence is generated by their reaction with a dye, fluroescamine, which is highly specific for primary amines. PAHs are naturally highly fluorescent so they can be detected directly. To permit the simultaneous detection of both target compounds, half of the cold finger is coated with the fluroescamine reagent, while the other half is uncoated. With the MOD

fluorescence analyzer, the target compounds can be readily detected at the sub-ppb level. If either amines/amino acids or PAHs or both are detected in the MOD-based screening of a sample this means that other organic compounds are also likely present in the sublimate. Thus, other organic detection instruments selected for MSL may want to interrogate the sublimed material to characterize these compounds. If an amine/amino acid signal is detected in the MOD-based analyses, the microfabricated chip-based CE separation device with integrated reaction chambers, pumps, and capillary sipper is used to gather the sublimate from the fluroescamine coated portion of the MOD cold finger and determine the amino acid composition and chirality in order to evaluate their origin. Of particular importance would be the finding that the amino acids are present as a non-racemic mixture (non-equal amounts of the D- and L-isomers), which could be suggestive of a biotic origin. The SCWE/MOD/CE suite combines with the MORS component that is used to determine the oxidative characteristics of the samples in order to provide data on the role of oxidation reactions in the survival of organic compounds in the Martian regolith. These oxidant data will be of particular significance if a negative result (no fluorescent signal above background is detected) is obtained by the MOD. MAP has the potential of performing the first successful detection of organic compounds on Mars. The finding of amino acids of possible biological origin would be a sensational result of interest to both the scientific community and the public. The MAP project also includes an extensive education and public outreach effort in order to transmit the results on a national and worldwide basis.